ANNALS OF PHYSICAL MEDICINE

The Official Organ of the British Association of Physical Medicine

VOLUME IV

1957 — 1958

London
BAILLIÈRE, TINDALL AND COX
7 and 8 Henrietta Street WC2

Editor
A. C. BOYLE

Assistant Editor
D. R. L. NEWTON

Editorial Board
D. C. ARNOTT P. BAUWENS H. A. BURT
S. MATTINGLY A. T. RICHARDSON G. O. STOREY
W. S. TEGNER D. WILSON C. B. WYNN PARRY

PRINTED BY
HEADLEY BROTHERS LTD
THE INVICTA PRESS ASHFORD KENT
AND 109 KINGSWAY
LONDON WC2

ANNALS OF PHYSICAL MEDICINE

The Official Organ of the
BRITISH ASSOCIATION OF PHYSICAL MEDICINE

Vol. IV February 1957 No. 1

EDITORIAL

THE first number of the ANNALS OF PHYSICAL MEDICINE was published in 1952 in response to a need for the British Association of Physical Medicine to have its own official journal. Launching a new medical journal is never an easy task, and time, together with unceasing effort on the part of those responsible, is needed for its development to maturity. The success of the ANNALS in its first five years is now reflected in its new format, and we are happy to extend a welcome to Baillière, Tindall and Cox Ltd., who have taken over its publication. A further step forward is taken in this issue, which includes the first article in a Revision Series which is to become a regular feature in subsequent numbers.

Five years ago, the late Lord Horder, as President of the British Association of Physical Medicine, wrote a foreword for the first number of the ANNALS. All Members of the Association will remember with gratitude his inspiring leadership which contributed so much to the success of the ANNALS in its early years. We are proud to reproduce the Presidential Badge of the Association as an emblem on the front cover of the ANNALS, and to introduce an annotation by the President which explains its significance.

THE PRESIDENTIAL BADGE

FEW members of the British Association of Physical Medicine will fail to be moved by the sight of the plate in this number of the ANNALS, for it is a photograph of their tribute to the memory of their first President, the late Lord Horder. As will be seen, it takes the shape of a presidential badge of office and carries the following inscription on the reverse:

> "In memory of the late Lord Horder, first President of the British Association of Physical Medicine, 1943-55. Subscribed by members of the Association."

The symbolism was born of sketchy suggestions from the Executive Committee and the imaginative artistry of the designer, Mr. A. G. Styles. The four elements of the ancient philosopher are represented and inconspicuously provide background ornamental motifs. The oval surround bears a wavy design to symbolize water, and a floral decoration, the growth from earth, while flames of fire form a foundation for the initials B.A.P.M. which surmount the frame. The fourth element, air, is implied in the deep blue enamel background to the central theme brought out in relief. This portrays a cripple being raised and supported by two other figures, the one on the dexter side symbolizing medicine, and that on the other side wearing a floral garland to indicate natural resources. The suggestion is the combination of medical knowledge and nature in a common aim for the good of man. In this context the blue of the background may be regarded as standing for truth and light.

Those of us who had the good fortune to know Lord Horder well will see beyond these symbols and find there the epitome of his own inspired thoughts in the field of physical medicine. And when the line of Presidents who knew him well runs out, it might be a fitting tribute to this great man who was our first President if part of the induction ceremony included a brief oration to keep alive his memory.

The design was executed in 9-carat gold and enamel by Garrard & Co. The fact that it was exempt from purchase tax as being a worthy example of contemporary art bears witness to the high quality of both design and workmanship.

P. BAUWENS, *President*

THE PRESIDENTIAL BADGE

commemorating the first President of the Association

Reproduced by kind permission of the Worshipful Company of Goldsmiths

THE THEORY AND PRACTICE OF ELECTRODIAGNOSIS

By A. T. RICHARDSON and C. B. WYNN PARRY

THE demonstration by Erb in 1883 of differences between the electrical response of innervated and denervated muscle, later elaborated into the faradic–galvanic test, indicated a new approach to the differential diagnosis of lower motor neurone and muscle fibre disease. The fact that the faradic–galvanic test proved to be an inaccurate means of detecting at the most nerve dysfunction, muscle denervation in total or in part, or fibrous degeneration of muscle soon led to a search for improved methods. It is, however, only recently, with the introduction of accurate quantitative methods and of electromyography, that the full value of electrodiagnosis has become apparent. Further, it is only now with experience of these methods that a description of a routine clinical method with standard terminology is possible.

In this article the anatomical and physiological basis of electrodiagnostic tests is described, the implication of the results of these tests in terms of neuromuscular pathology discussed, and a routine clinical method based on the estimation of nerve conduction, plotting of strength–duration (I/T) curves, and electromyographic exploration of muscle presented.

ANATOMY AND PHYSIOLOGY

Modern electrodiagnosis is based on an accurate knowledge of the applied anatomy and physiology of voluntary muscles and their nerve supply. It is, indeed, lack of this knowledge that is responsible for many of the common errors—for example, those based on the belief that the nerve supply of the hand is constant or that denervated muscle cannot respond to faradism and that a regenerated nerve necessarily can.

THE MOTOR UNIT

The functional unit of voluntary muscle is the motor unit described by Sherrington, which consists of a motor nerve cell in the anterior horn of the spinal cord; its efferent nerve fibre, which branches both inside and within the muscle belly to terminate finally in the motor end-plates; and the 300 or so muscle fibres supplied by the lower motor neurone. That the many muscle fibres of a single motor unit lie adjacent in a compact group or groups (branched units) has been demonstrated histologically by Wohlfart and Swank (1941).

Further support for this derives from the distribution of such electromyographic phenomena as fasciculation potentials, as well as the occasional observation in superficial, partially denervated muscles that on contraction a single potential of motor-unit form corresponds to a well-defined narrow longitudinal band extending the length of the muscle belly. The relationship, if any, between the number of muscle fibres of a motor unit and the size of its motor nerve cell and efferent fibre is not fully established, although correlation of change in nerve-conduction time (Hodes, 1948) and the dimension of the motor-unit potential in such diseases as anterior poliomyelitis should supply the information. There is, however, no doubt of the variation in the size of the motor units in voluntary muscle as judged by their motor-unit potentials and their different recruitment. Thus a normal voluntary effort is initiated by the activation of the smaller motor-unit potentials each discharging asynchronously at 10 to 30 per second, and it is only at the point of fatigue or on intense effort that the large motor-unit potentials can be seen.

Electrophysiology

The electrical changes associated with activity of various parts of the motor unit are typical of those which characterize all excitable tissues, and which have been most fully studied in nerve fibres (Hodgkin and Katz, 1949). At rest such fibres exhibit a potential difference across their surface membranes (resting potential), a difference that can be correlated with the distribution of ions inside and outside the cell. In particular, there is a high concentration of diffusible potassium inside the cell, where it is held by the fixed anions, and a low concentration of the less diffusible sodium, which is actively pumped out as it enters. During activity it appears that permeability to sodium ions is increased, allowing them to enter the cell under diffusion and electrical forces, reverse the resting potential and allow the escape of some of the intracellular potassium. This so-called "depolarization", which is in fact a reversal of polarity, constitutes the action potential. It gives rise to a current flow chiefly via the medullary nodes (Huxley and Stampfi, 1949) which is capable of stimulating the adjacent fibre with consequent propagation of the depolarization (and the impulse) along the nerve fibre.

On arrival at the motor end-plate the nerve impulse brings about the release of acetylcholine, which, for the brief time before it is destroyed by cholinesterases, chemically depolarizes the end-plate with the production of a local non-propagated end-plate potential. This in turn excites the adjacent muscle-fibre membrane with the production of an action potential which is propagated along the muscle membrane (cf. nerve fibre) and followed by contraction of the muscle protein.

It is the propagated action potentials of nerve and muscle fibres, particularly the latter in areas remote from the motor point, that are studied in electromyography. Further, it is the study of the threshold intensity of various electrical stimuli required to activate nerve and muscle fibres which forms the basis of the other electrodiagnostic tests. The physiological properties of excitability, accommodation, or latent addition (facilitation) can be determined in this way by relating the intensity of the threshold stimulus to its duration, shape, or frequency.

EXCITABILITY OF NERVE AND MUSCLE

The excitability of nerve or muscle is most conveniently expressed graphically as the strength–duration (intensity-duration or I/T) curve. All quantitative electrical measurements of such excitability are merely abbreviations of the I/T curve.

Intensity–Duration Curves

Complete I/T curves of voluntary nerve and muscle are obtained by determining the intensity (expressed in milliamperes or volts) of an electrical stimulus required to produce a minimal contraction of the muscle for various durations of that stimulus (expressed in milliseconds). The apparatus used for these measurements delivers a rectangular wave form of current or potential (square pulse) which allows accurate measurement of both the intensity and the duration of the stimulus. If such a stimulus is delivered to a normally innervated muscle directly or to its motor nerve the result is substantially the same. This is because the muscle fibres are less easily stimulated than the intramuscular nerve fibres; the apparent direct stimulation of the muscle is in effect indirect only via the more sensitive nerve. In this way the I/T curve obtained from normally innervated muscle expresses the excitability characteristics of nerve fibre (Fig. 1). This shows that the rheobase (intensity at 300 msec.) is effective for 100, 30, and 10 msec.; an increase of stimulus intensity becomes necessary between 10 and 1 msec. or between 1 and 0·1 msec., but the threshold at 1 msec. is less than twice the rheobase. In contrast, when lower motor neurone degeneration has occurred or a state of neuromuscular block exists, only direct stimulation of the muscle fibres will be effective, and resultant I/T curves express the excitability characteristics of muscle fibre (Fig. 4). This shows that the rheobase becomes ineffective below 100 msec., and that at 1 msec. the threshold intensity is considerably in excess of twice the rheobase and the curve ascends rapidly in a parabola. In the latter conditions the motor point—that is, the point at which the branching nerve enters the muscle and, therefore, the point of greatest concentration of nerve fibres—loses its significance as the point at

which the stimulus is most effective. The stimulus in these conditions becomes more effective when the position of the electrodes allows the stimulating current to flow through the greatest number of muscle fibres. This phenomenon is called the longitudinal reaction.

Polar Test and Type of Response

It is well known that when the electrodes are arranged so that the cathode is used as the stimulating electrode a smaller threshold current is required for a normally innervated muscle than when the anode is used (K.C.C.>A.C.C.). In denervation this polar formula is reversed (A.C.C.>K.C.C.), but the change is inconstant and, therefore, the so-called polar test, which had a long ancestry, has become defunct. It is, however, because of this polar difference that the cathode should always be used as the stimulating electrode.

The response of innervated muscle to electrical stimulation at body temperature is normally brisk. This may be used as an index of the functional state of the muscle fibre. The change to a sluggish response in denervation is remarkably constant; indeed, Erb has said: "In denervation a slow, long-drawn-out contraction occurs which passes into continuous tetanus lasting the entire duration of the current with relatively feeble current. I regard the slowness of contraction as especially typical of denervation and present in all circumstances." The cause of this sluggish response has not been satisfactorily explained. Doupe (1943) showed that abnormal muscle responds repetitively to stimulation by constant current, and this causes a prolongation of contraction. Similarly the repetitive firing of muscle fibres on electrical (or mechanical) stimulation in myotonia (myotonia congenita and dystrophia myotonica) produces an apparently sluggish response. The relation of the electrical field to the muscle fibres in denervation may also be of importance in the production of the sluggish response, and finally any changes in the actual protein of the muscle fibre cannot be excluded. In this connexion it is of interest that in myxoedema and in cold muscle responses become sluggish.

Rheobase, Temps Utile, and Chronaxie

Study of the full I/T curve allows definition of two important points: these are the rheobase and the chronaxie. The definition of the *temps utile* of Lapicque is now of academic interest only.

1. *Rheobase.*—No matter how prolonged the square pulse stimulus used (provided it is greater than 100 msec.), a definite minimal intensity is required to elicit a response. This is called the rheobase, normal values being between 2 and 8 mA or 15 and 30 volts. Harris (1952), who carried out determinations of the rheobase with an exacting technique, found that the value depends not only

on tissue excitability, but also on skin resistance in that it fell with a rise in skin temperature and rose with a fall. Further, ischaemia and local oedema cause a rise, as do measurements taken at a distance from the motor point. However, the rheobase of a muscle is fairly constant provided a strict technique is used. This measurement remains of importance in electrodiagnostic work, for in general the rheobase drops to low levels in denervation, to rise again with commencing reinnervation. Pollock (1947) regards a sudden rise in the rheobase as unequivocal evidence of recovery, and states that it often antedates clinical signs by many weeks. Wynn Parry (1953), however, measuring it in a series of patients with peripheral nerve injuries, found that the changes in denervation and reinnervation were not constant, although when they occurred they were significant. A more gradual rise in the rheobase could, of course, also indicate commencing fibrosis, and, finally, a high rheobase occurs in primary muscle fibre degeneration.

2. *Chronaxie.*—The chronaxie of a muscle is defined as the time for which a current of twice the rheobase has to act to produce a just perceptible contraction of the muscle. The value of chronaxie may be read off the I/T curves or determined by the use of condenser discharge technique. This latter is based on the fact that the time of discharge of a condenser is proportional to its capacity if it is discharged through an unvarying resistance. Thus by charging a series of condensers to a potential of twice the rheobase and discharging them in turn through the muscles, the minimum time needed for this voltage to act to produce muscle contraction may be determined. This time should be, of course, the chronaxie of that particular muscle, but Bauwens (1951) has levelled serious technical criticisms at this method.

Ritchie (1945) has shown that the value of chronaxie depends entirely on the technique used, and points out that single estimations of the chronaxie are of little value. In general it may be said that chronaxie of nerve lies in the range of 0·05 to 0·5 msec., and chronaxie of muscle between 1 and 100 msec., the shorter values being obtained with voltage output stimulators. Newman and Livingstone (1947), Bauwens (1951), Ritchie (1954), and Harris (1956) have shown that the chronaxie is of no use in anticipating recovery.

Nerve Conduction

A normal I/T curve implies the presence of normal nerve conduction, which can also be demonstrated by the production of muscle contraction on stimulating the nerve trunk anywhere in its peripheral course. This forms the basis of nerve-conduction tests in which either the threshold stimulation intensity or the actual conduction time of peripheral nerves is measured. The former is a very simple and sensitive test of the functional state of the nerve as shown by the

existence of the normal depolarization mechanism, which necessitates intact nerve fibre with normal ionic distribution and myelination.

Loss of nerve conduction due to lesions between the point of stimulation and the muscle may be due to any dysfunction of the nerve (e.g. neurapraxia), but loss of nerve conduction due to a lesion proximal to the point of stimulation implies lower motor neurone degeneration. Degenerative lesions of a nerve result in a cessation of conduction in the peripheral portion in approximately 72 hours. It must be emphasized that after regeneration it is most difficult to excite a nerve fibre, although it can conduct an impulse initiated in the motor cell. Thus voluntary movement may be present in the absence of a response on peripheral nerve stimulation. Indeed, Erb said in his book: "Regeneration must persist further for excitation than for conduction." The so-called myasthenic reaction, which is a fatigue of the muscle response to repetitive nerve stimulation, and the myotonic reaction, which is a persisting muscle contraction to electrical stimulation (much better obtained mechanically), are useless in practice.

Faradic–Galvanic Test

By definition a faradic current is a short-duration current (1 msec. or less) obtained from an induction coil, most coils having an intensity below 110 volts. A galvanic current is a direct current—that is, one of long duration (100 msec. or more)—conventionally obtained from a galvanic battery. The theoretical basis of the faradic–galvanic test can be surmised from the full intensity-duration curve, although in fact neither type of stimulus can be measured in terms of intensity or duration with any accuracy. Thus in the majority of subjects only nerve will respond to a faradic stimulus, whereas both nerve and muscle respond to a galvanic stimulus provided they have not undergone fibrous degeneration. In practice it is well established that denervated muscle can respond to a faradic current (Ritchie, 1954), as can be deduced from the I/T curve (Fig. 1), which indicates that the necessary conditions exist when the intensity of the stimulus is high, and particularly if in addition the rheobase is low. Further, voluntary movement may return before a faradic response. With the introduction of electronic stimulators the faradic–galvanic test should be rejected in favour of plotting full I/T curves or, if an abbreviation is required, the accurate measurement of the 100/1 msec. intensity ratio.

ACCOMMODATION OF NERVE AND MUSCLE

Bordet (1907) was the first to point out that measurements of accommodation can distinguish denervated from normal muscle. This differentiation depends on the property of normal nerves to adapt themselves to stimuli which take time to reach their maximum intensity, a property not possessed by denervated

muscle or nerve in tetany. Two methods of electrodiagnosis depend on the detection of the difference between the accommodation of normal nerve and lack of it in denervated muscle; they are the progressive current ratio and the galvanic tetanus ratio. A third method which may conveniently be considered in this group is the plotting of strength–frequency curves, which depends partly on this property but also upon stimulus duration and repetition rate.

Progressive Current Ratio

In normally innervated muscle the threshold for contraction for a stimulus slowly rising in intensity (saw-tooth pulse) is greater than that for a rapidly rising stimulus (square pulse) because the nerve accommodates, whereas in denervation the two approximate because the muscle cannot accommodate. The progressive current ratio is defined as the ratio of the threshold for contraction with a progressive current (saw-tooth pulse) to the threshold for contraction with a square pulse of indefinite duration (rheobase). Solandt (1935) and Kugelberg (1944) found the progressive current ratio a useful index of recovery. The value of this method has yet to be fully explored in clinical electrodiagnosis; indeed, electronic stimulators providing saw-tooth pulses have only recently become generally available. In theory the method has a great deal to commend it; in particular the application of saw-tooth pulse to a partly denervated limb with resultant stimulation of the non-accommodating denervated muscle can be contrasted with the application of short duration (1 msec. or less) square pulse with resultant contraction of the normally innervated muscle, and thus can be used as a screening test for the presence of the former. The fact that all nerve fibres accommodate to saw-tooth pulses results in this type of stimulation being relatively painless, hence its value in treating denervated muscle.

Galvanic Tetanus Ratio

A direct galvanic current flowing for several seconds with high intensity (5 to 10 times the rheobase) through a muscle will produce a tetanic contraction. The ratio of the intensity of this current to the rheobase is called the galvanic tetanus ratio. In denervation the ratio approaches unity. Pollock (1945) found it a sensitive method of detecting denervation, but also found that its application was painful to the patient. Newman and Livingston (1947) described a rise in the galvanic tetanus ratio to 3 in 48 % of peripheral nerve injuries at an average of 109 days before voluntary conduction was noted.

Strength–Frequency Curves

In this method, the use of which in lower motor neurone lesions was first described by Hill, Katz, and Solandt (1936), the amount of current required to cause a minimal contraction (expressed in milliamperes) is plotted against

the frequency of the current used (expressed in cycles per second). The frequency range generally used is from 20 to 1,000 cycles per second (c.p.s.). Differentiation of denervated and innervated muscle depends on the fact that each has a different optimum frequency to which it responds. The optimum frequency for normally innervated muscle is about 60 to 100 c.p.s. In denervated muscle the threshold amperage is increased for high frequencies but much diminished for low ones, with an optimum frequency about 1 c.p.s. During regeneration there is a diminution in the threshold amperage for the high frequencies, which becomes relatively greater as the frequency diminishes. Another feature during degeneration and regeneration is the appearance of discontinuity in the curves.

Pollock *et al.* (1945) have given a complete account of the method, which, however, has several serious drawbacks, notably that the tetanus response to this type of current develops so gradually that it is difficult to get a definite end-point. Further, the threshold between 20 and 100 cycles varies only 20 %—too little to allow for high accuracy (Ritchie, 1954). Finally, as Rodriquez, Kendall, and Ivy (1951) have shown, these curves can be most bizarre, particularly in recovery, and therefore extremely difficult to interpret.

REPETITIVE STIMULATION OF NERVE AND MUSCLE

The threshold intensity for repetitive stimulation of muscle is related to the interval between the stimuli. This is because a short sub-threshold stimulus can modify the muscle for a limited time so that a following sub-threshold stimulus summates with it, thus causing excitation. Facilitation (or latent addition) exists when a tissue is more excitable to repetitive stimuli than to a single stimulus of the same duration. The ratio of the threshold current for a single stimulus to the threshold current for repetitive stimuli is called the facilitation ratio. In general this ratio is highest in denervation (increased facilitation) and drops early in regeneration.

Strength–Interval Curves

These curves are constructed by plotting the threshold intensities of repetitive stimuli (usually of 5 msec. duration) against the intervals (usually 1 to 30 msec.) between them. Clearly the shorter the interval between stimuli the greater the facilitation, and, as this property is also greatest in completely denervated muscle, the lowest threshold is needed for stimulation of those muscles at the shortest interval between stimuli. Although this method is sound in theory (Dobin, 1952), the apparatus and technique for plotting these curves are complex, and there is some difficulty in selecting a duration of stimulus applicable for the determination of any facilitation in both innervated and denervated muscle. The method seems unlikely to be used in clinical work.

PATHOLOGY OF THE MOTOR UNIT

Lesions of the motor unit may affect either the lower motor neurone or the muscle fibres, or both. Lesions affecting the motor unit at the level of the cord or brain-stem may be termed myelopathic lesions; lesions affecting the efferent fibre, neuropathic; those affecting the muscle fibre, myopathic; and, finally, combined nerve and muscle fibre degeneration may be called a neuromyopathic lesion. Such terminology is convenient for use in electrodiagnosis, as it is in accord with the implications of the electrical changes observed. Thus while the lower motor neurone—that is, the motor cell and its efferent fibre—is one cell, there is evidence that diseases causing dysfunction of the lower motor neurone at the level of the motor cell can be differentiated from those affecting the efferent fibre peripherally.

Some confusion exists in correlating electrodiagnostic findings with clinical syndromes. In general it may be said that myelopathic lesions—that is, those in which clinically the lower motor neurone lesion is accompanied by upper motor neurone or other long tract signs—include the motor neurone diseases (amyotrophic lateral sclerosis, progressive muscular atrophy, and Werdnig–Hoffman disease), peroneal muscular atrophy (Charcot–Marie–Tooth), vascular lesions of the cord (including those caused by cervical spondylosis), anterior poliomyelitis and other forms of myelitis, syringomyelia, and the rare diabetic myelopathy. The pathological basis of the electrodiagnostic changes as evidenced by electromyography is that these lesions either selectively destroy the anterior horn cells, so altering recruitment of the motor units, or produce this altered recruitment by additional involvement of the internuncial or upper motor neurones or perhaps both. Myelopathic lesions, as in the case of lesions anywhere in the central nervous system, may excite or depress function. In lower motor neurone lesions (myelopathic or neuropathic) excitation gives rise to fasciculation, and the latter to paresis. Paresis of a lower motor neurone, however, does not necessarily imply degeneration of that neurone even when the nerve cell is involved—for example, in anterior poliomyelitis, where motor-cell dysfunction by oedema can be created without degeneration. This dysfunction, which can be differentiated electrodiagnostically, is particularly important in myelopathic lesions because degeneration of the anterior horn cell precludes recovery.

Neuropathic lesions include traumatic peripheral nerve lesions (injuries and the pressure syndromes, e.g. carpal tunnel syndrome) and various forms of polyneuritis and mononeuritis multiplex. Again, if these lesions paralyse they do not necessarily do so by causing degeneration of the nerve. In relation to non-degenerative lesions, while traumatic neurapraxia of the nerve—that is, physiological block of conduction without degeneration—is well recognized, periaxial segmental denervation (patchy peripheral demyelination) as the pathological

basis of multiple peripheral nerve dysfunction without degeneration is not.

The only dysfunction of neuromuscular transmission which is likely to be referred for electrodiagnostic investigation is myasthenia gravis. This syndrome, in which the essential feature is the existence of a competitive inhibition neuromuscular block, may produce electrodiagnostic evidence of a myopathy. The characteristic feature is a pharmacological abnormality which can be demonstrated by studying the electromyographic response of muscle to neuromuscular blocking agents of either the competitive inhibition or, more characteristically, the depolarizing group.

Myopathic lesions include not only the hereditary muscular dystrophies, polymyositis and dermatomyositis (which may also produce a neuromyopathy), but also such non-degenerative disturbances of the muscle fibre as occur in familial periodic paralysis and other upsets of the normal ionic pattern (e.g. primary aldosteronism and potassium-losing nephritis). Finally, it is important to distinguish dysfunction of the muscle-fibre potential from abnormalities of contraction. Thus the sluggish contraction of muscle which occurs in denervation also occurs when the muscle is cold and in myxoedema, conditions in which there is no change of the membrane potential. Also denervated muscle can be made to contract by mechanical stimulation in the absence of any action potential.

ROUTINE CLINICAL ELECTRODIAGNOSIS

As has already been stated, the most suitable procedure for routine clinical electrodiagnosis is, first, the estimation of nerve conduction; secondly, the plotting of intensity–duration curves, including the study of the type of response and the rheobase; and lastly, if necessary, electromyography. The problem to which it is applied is that of muscle weakness or wasting.

CLINICAL ESTIMATION OF NERVE CONDUCTION

This is carried out with a 0·3 msec. stimulus which is applied to the peripheral nerve supplying the muscle to be investigated at gradually increasing intensity until a minimal muscle contraction is obtained. This should preferably be compared with the normal contralateral limb or related to the fairly constant figures which are obtained from standard electrode positions and learned by experience. Convenient points for stimulation are the facial nerve at the stylomastoid foramen, Erb's point (5th–6th cervical roots) in the neck, the radial nerve above the elbow, the median and ulnar nerve at the elbow and wrist, and the medial and lateral popliteal nerves at the knee. The stimulating electrode is placed over the nerve, with the other electrode proximal to it or, in the case of Erb's point, behind the neck. The latter should also be used as "earth" electrode position for nerve-conduction estimation of the facial nerves.

By this means several valuable observations can be made. First, the true distribution of the nerve supply can be determined, for, as Seddon (1954) has commented, considerable variation exists, particularly in the small muscles of the hand. Secondly, the presence of conduction in the nerve at a point distal to the lesion after a few days indicates that the lesion at that time is non-degenerative. An example is the technique used by Brooks (1954), who showed that the retention of nerve conduction in poliomyelitis at four weeks indicates a good prognosis; if absent, a bad one. Thirdly, if the lesion is non-degenerative, definition of the point above which nerve stimulation is ineffective locates it. Fourthly, some peripheral nerve lesions give a characteristic response to peripheral nerve stimulation. Thus, on stimulation of the radial nerve in a posterior interosseus nerve palsy, the responses of the brachio-radialis and extensor carpi radialis are retained with an absent or diminished response in the extensor carpi ulnaris and extensors of the digits. Yet again, in a C.7 lesion, nerve conduction in the brachio-radialis (C.5–6) remains unimpaired with loss of the wrist and digit extensors. Another example is the stimulation of the median nerve at the wrist in a carpal tunnel syndrome, in which the response tends to be retained in the lumbricals but not the thenar muscles, and stimulation of the lateral popliteal nerve in an L.5 lesion which produces response in the S.1 components to the peronei (L.5–S.1) but not in the L.5 components to the anterior compartment or peronei—a finding in contrast to that in lateral popliteal nerve lesions, in which all responses are lost equally.

INTENSITY–DURATION (I/T) CURVES

The all-important consideration in plotting I/T curves for clinical purposes is a constant technique. This implies the use of an accurate electronic stimulator, and a rigorous technique involving the use of constant-size electrodes placed in standard positions. Further, a constant positioning of the muscles to be tested is necessary, and familiarity with the end-point.

There are two types of stimulator in use, that with a constant current (high impedance) output and that with a constant voltage (low impedance) output. Stimulator performance is of great importance—rise times must be negligible compared with pulse durations, wave forms flat-topped for all pulses, and amplitude variations over the range of pulse durations and variation of the pulse repetition frequencies should be less than 5%. Stimulators must be tested regularly (at least every six months), as alterations in performance may not become obvious clinically.

Constant Current Output Stimulators

This type of stimulator delivers a square pulse of stabilized intensity which may be varied between 0 and 50 mA and measured accurately. Constancy of

intensity for variable patient loads (arising from variation of tissue resistance and capacity) is obtained by using an output impedance of 100,000 or more ohms, usually supplied by a pentode valve.

Constant Voltage Output Stimulator

The constant voltage output stimulator delivers a square pulse of stabilized voltage variable between 0 and 200 volts and which can be accurately measured. Constancy of the output intensity is obtained by using a low impedance of 500 ohms or less or a low value resistance shunting the output. In general, it may be said that the stimulus delivered from a constant voltage stimulator is better tolerated than that from a constant current stimulator, but stricter precautions must be taken to lower resistance of the skin. However, Wynn Parry (1956) has described experiments comparing two such stimulators, and he concluded that in practice both types give accurate results and that the skin resistance factor has been over-emphasized.

It is generally agreed that eight pulse durations are essential, the usual pulse being 300, 100, 30, 10, 3, 1, 0·3, and 0·1 msec. A technical refinement of practical value is the use of a meter with a logarithmic scale to read the intensity, and to incorporate in this the variable shunting which can be brought in the circuit. This elaboration allows the sensitivity of the meter to be altered and so reduce the value of the voltage or current to unity; in this way intensity readings can be expressed in multiples of the rheobase. I/T curves should be recorded graphically using logarithmic scales. Figs. 1, 2, 3, and 4 show examples of these curves.

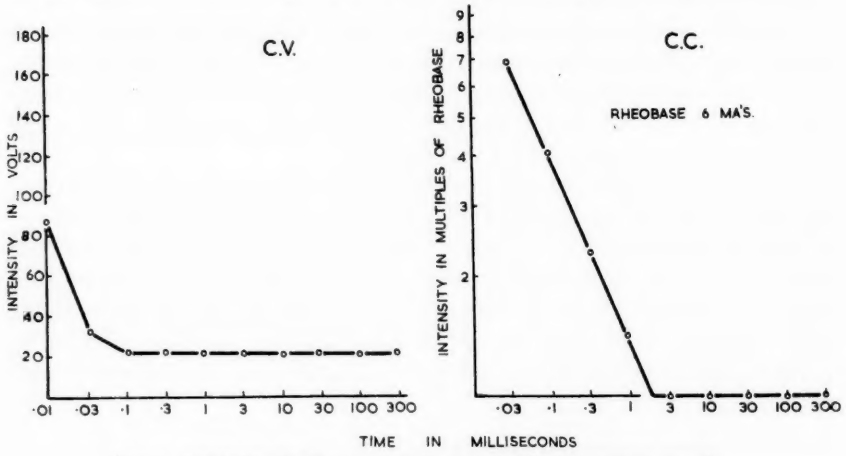

Fig. 1. Intensity–duration curves from normally innervated muscle.
C.V. using constant voltage stimulator.
C.C. using constant current stimulator.

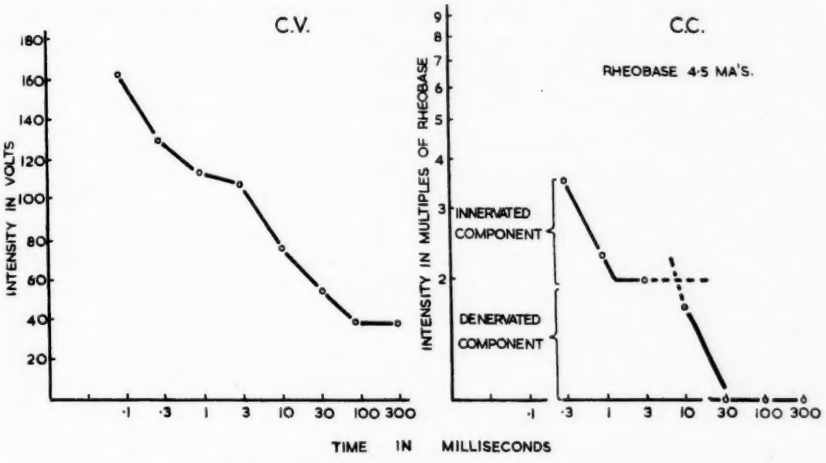

Fig. 2. Intensity–duration curves from partially denervated muscle.
C.V. using constant voltage stimulator.
C.C. using constant current stimulator.

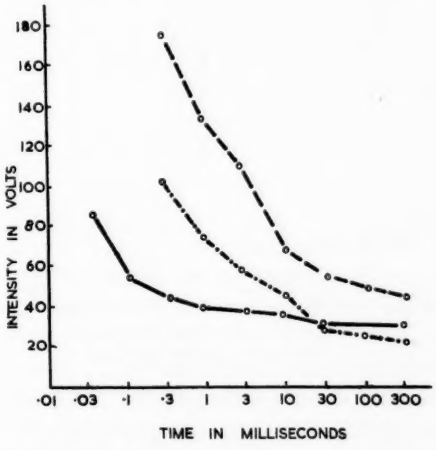

Fig. 3. Intensity–duration (constant voltage) curves from abductor digiti minimi following ulnar nerve suture.
A. — — — 4 months after suture.
B. — · — · $5\frac{1}{2}$ months after suture.
C. ——— 9 months after suture.

Fig. 1 shows the I/T curve obtained from normally innervated muscle; this satisfies the criteria of nerve excitability already described. In normal muscle this curve would be associated with normal rheobase (2 to 8 mA or 15 to 30 volts) and a brisk response. Normal I/T curves associated with a high rheobase suggest a myopathy, and such a curve with a sluggish response suggests either cold muscle or myxoedema. This curve can be conveniently expressed as 100/1 msec. ratio of less than 2, but in general, and unless the investigator has considerable experience, the full I/T curves should be plotted.

Fig. 2 shows a curve of partial denervation which is intermediate between the curves characteristic of nerve and muscle excitability. This results from the integration of two distinct curves, one representing an aggregate response of innervated fibres, the other that of denervated fibres. It is the ratio to normal of denervated motor units which determines the slope of the different portions of the complex curve as well as its over-all shape. Alteration in one type of curve to another indicates progressive denervation or recovery according to the trend. (Fig. 3, A, B, C.)

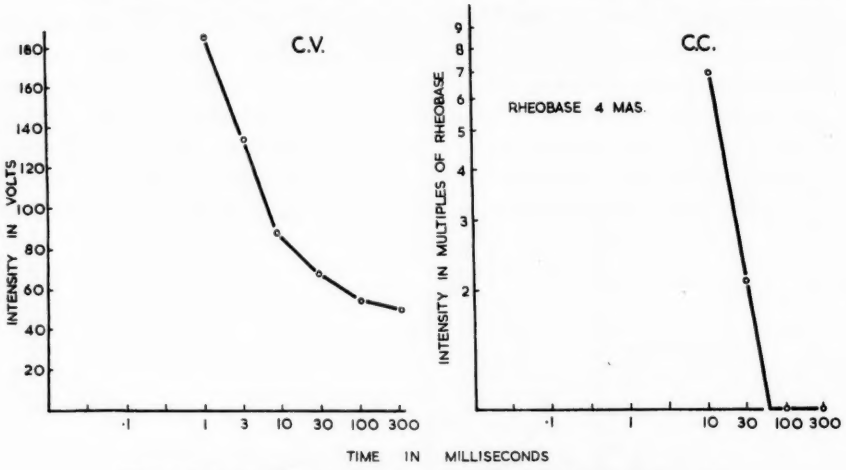

Fig. 4. Intensity–duration curves of completely denervated muscle.
C.V. using constant voltage stimulator.
C.C. using constant current stimulator.

Fig. 4 shows the curve of completely denervated muscle which satisfies the criteria of muscle excitability. In denervation this curve is associated with a low rheobase unless recovery is impending or progressive fibrosis has occurred. Association of this type of curve with a high rheobase may also indicate a combined lower motor neurone and muscle-fibre lesion (neuromyopathy).

(To be concluded, with full list of references)

ORIGINAL PAPER

PHYSICAL MEDICINE AND MODERN PHYSICS*

By SVEND CLEMMESEN

THE object of science is to collect experience and observations, to examine the pattern of these phenomena, and to seek for regularities in these patterns so that they will allow us to attempt a description of them in axioms and laws. Gradually the unending woven pattern is revealed to us here and there. "We know partially." "We look through a loophole into the darkness." With the deepest respect we try to read the pattern and endeavour to enlarge the knowledge inherited from our ancestors, and only derive from our analyses that our knowledge is woefully incomplete. As time moves on we come to know and to realize the important aspects of what we do *not* know.

Again as time passes, our knowledge of the intricate details of the pattern changes, and with this added knowledge we are able to perceive a change in the pattern itself. According to our new experiences and observations, we have to view the pattern in a new light—our viewpoint has to be reconsidered. Thus does the gradual evolution of ideas take place.

It is with the deepest personal respect that I address you now. I am awed by the honour granted to me in following many distinguished predecessors in this room, and yet fortified by the presence of so many illustrious and distinguished colleagues who have come to this city of ours in allegiance to the search for the fundamental laws of physics as they are applied to medicine.

PHYSICS THE FUNDAMENTAL SCIENCE

Within the science of physics the observations from the outer world have been gathered, and knowledge won concerning the natural forces. Within physical medicine physics are used with medical purpose. "Our brief is a wide one", as my dear predecessor, the late Lord Horder, wrote in 1952. Just as chemistry may be said to be the basis of internal medicine, so in the discipline of physical medicine physics is the fundamental science. It is on physical principles that we base our specialty, for prophylaxis, for treatment and rehabilitation, and also especially have we employed the modern developments and advances in the instruments of physics to our methods of diagnostic assessment and evaluation of our patients. "We must study the action of physical agents and their application in the promotion of health, in the prevention and treatment of

* Presidential Address delivered to the Second International Congress of Physical Medicine, Copenhagen, August, 1956.

illness and injury, and in the restoration to fitness." Thus the aims were described by the British Association of Physical Medicine in 1943. We will not only treat the sick, but strive to make nearly fit people quite fit.

Let us be bold enough to try and transfer the latest chain of reasoning from modern physics to physical medicine. A special obligation in this respect rests upon us in this country, where Niels Bohr has melted philosophy and physics together so successfully into a fruitful chain reaction. This is the reason why I, in spite of being an amateur in science and only a dilettante, have summoned all my courage to mention here the different concepts derived from modern physics where a transfer to physical medicine and physiology would seem to me to be useful.

Niels Bohr has pointed out how the new advances in physics have had their effects upon our whole philosophy throughout the centuries. Through his philosophy and experiments he has been influencing modern physics. It must be our duty now to begin to transfer the fruitful modern reasonings from physics and philosophy back to our daily problems.

DEVELOPMENTS IN THE LAST CENTURIES

Physical medicine itself is probably as old as mankind. Let us now for a while consider the developments of physics through the last centuries, and see how the new concepts in physics have been influencing our whole philosophy. Let us be bold enough to try to transfer the latest chain of reasoning from modern physics forward to physical medicine.

The Pole Nicolaus Copernicus in the early sixteenth century (1473–1543) had practical medical experience together with his astronomical investigations, and he elaborated his system with the different planets circling round the sun. As a philosophical deduction he understood and underlined the relativity of the movement and the fact that we are not allowed to conclude from our own concept of existence what is the *real* nature of the universe.

The Italian Galileo Galilei (1564–1642) began to study medicine, but his experiments with the fall of heavy objects thrown down from the famous leaning tower of Pisa, and his construction of the telescope, determined his ultimate fate. It was he who began the experimental line in physics and astronomy and who discovered the daily rotation of our globe.

The Englishman Isaac Newton (1642–1727) gave us the differential calculus and combined it with the integral calculus. He studied experiments on the refraction of light. He explained the forces keeping the planets in their courses through the reciprocal attraction between spheres. He philosophized concerning a light ray passing to the human eye. He supposed that there must be an emission of actual particles hitting the eye (his theory of emission). His

discoveries have been fundamental to modern physics, chemistry, and astronomy. The fundamental laws of gravity were evolved from this man's capacity to think, and from his thoughts conceived from the simple observation of the apple falling off the tree. Our whole philosophy and comprehension of the universe has been remodelled through the understanding of reciprocal attraction between bodies great and small.

The reciprocal interaction between subject and object, in psychology and in philosophy, had an illustrative, convincing parallel. This concept of reciprocal interaction proved most useful during the period of development in modern chemistry and electricity. Even the modern community has been developed through a growing understanding of the laws concerning action and reaction.

Let us also mention the Dane Hans Christian Orsted, of the mid-nineteenth century (1777–1851), who discovered the interacting forces of magnetism and other electric phenomena, and the Frenchman Antoine Laurent Lavoisier (1743–1794), who determined the correct explanation of the processes of burning and who brought "weight" and "relative amounts" into correct relationship in chemistry; the Englishman James Maxwell (1831–1879), who worked on the interaction between electricity and magnetism; and the Russian Dmitri Ivanowitch Mendelejeff (1843–1907), who developed the periodic system of the natural elements.

In spite of all this, it may be said that our conceptions to-day have been too material, too mechanistic, and too stolid, both in microcosm and in macrocosm, in astronomy and in philosophy. It is a fundamental fact that it was *always* discussed in an "either–or" method of thinking—an action and a reaction.

The German philosopher Georg Wilhelm Friedrich Hegel (1770–1831) had found it a fundamental law of our method of thinking that progression should take place through consideration of logical contrasts. To understand a concept, he stated that its logical contrast must be found, examined, and compared with the first statement. His thoughts play to and fro between apparent contrasts. The thought considers the "unity" or liaison with which the contrasts are linked to each other. A synthesis takes place, and through logical reasoning a further step forward is taken. In spite of much misuse by himself and others, this so-called dialecticism, this "either–or" method of thinking, still contains a certain component of the more modern conception, which may be described as of a "both-and" nature in contrast to the "either–or" basis. This has nowadays found a new, free, deliberate, and conscious formulation by Niels Bohr in his theories of complementarity.

The German Max Planck (1858–1947) evolved, at the beginning of this century, the idea of the "quantum-of-action" related to frequency and wavelength of radiation. According to his theory, radiation takes place in a

discontinuous beam. The quantum theory was formed. The indivisibility of the quantum of action had its consequences, for the conception of causal relation had to be modified when quanta were considered. The limitations of the practicability of a separation between a phenomenon and the observation of it became evident. This fact should be remembered more often than it is in medicine and in biology, when we deal with cells and minute structures within the cells.

The German-American Albert Einstein (1879–1955) in recent years developed his theory of relativity. For the first time in history the concepts built upon our own daily experience and the description of our intimate surroundings were consciously deserted. It must suffice here to mention how Einstein elucidated the limitation of our possibilities of observation and initiated a free attitude towards the concepts of time and space. He maintained the relativity of synchronism. He drew parallels between the electromagnetic theory and astronomy and even philosophy, and came much nearer to the desired unity of description of nature than any others have before him.

Let me use an example. A star is exploding at a mere bagatelle of a distance some million astronomic light-years from us. A ray of this star is caught by a cell of my eye and registered as light, long after the actual destruction of the star has taken place. Through what we may feel as an almost unending space of time, the ray will still pass down to earth, even if the star no longer exists as a star and is existing only as light. When a "quantum-of-action" of this light energy has been stopped by my retinal cell, what is happening to this amount of energy? May the light from the star be said to exist when no one is watching it? Yet the light of the non-existent star will exist somewhere long after I myself have ceased to exist. It is a star to me, even if it is in fact no longer a star.

The observation of the star is only a brief encounter in space and time between one cell and one ray. The relativity of the relation is obvious and the event due only to a coincidence between time and space co-ordinates. The absolute synchronism within the event is apparent only, because the light energy is transmitted discontinuously in quanta, even if we do not feel it in that way.

Here I must consciously, but with regret—my time is too short—omit a detailed history of the developments of "electronics", which have given such important tools of scientific estimation in physical medicine. Niels Bohr (born 1885) realized the impossibility of using the classical physical description of nature in relation to the structure and behaviour of atoms and electrons. He formulated his atomic theory in 1913, blending the deductions from the theories of Planck and Einstein as well as from the purely physical mechanical laws of Newton. Thus Philosophy and Physics became amalgamated.

RECONSIDERATION OF THE THEORY OF COGNITION

The experience won from modern theoretical and experimental physics has forced us to a reconsideration of our theory of cognition, our whole epistemology. It is, however, a long way before we can adjust our thoughts fully to these new abstract ideas, in spite of all the very convincing results from the atomic world. Our brain has been organized in such a way that dualisms are difficult for us to accept. We cannot imagine a concept to ourselves except by means of contradistinction or comparison to the logical contrary term. Light is understood only in contrast to darkness, sickness in a certain contrast to health, and so on. Sickness without some comparison to health will have for us no meaning. Light without its contrast, darkness, or at least relative darkness, is not accepted by our intellect. At the same time we are accustomed to an "either–or" and the "right-and-wrong" method of presenting our problems in mathematics, physics, and medicine, as well as in our daily life where we, in practice, are said to accept a "free-will".

Now the modern philosophy from these theories of physics has shown us that this mode of "either–or" thinking will be wrong in many cases. The theory of what I have called the "both–and" method *should* be accepted, following Bohr's concept of complementarity.

Here the classical example is the question, "Is light particles or waves?" If it is waves, it is not particles, and if it is particles, it is not waves. If we examine a ray of light we find that it behaves like particles. If we examine the ray by methods used to demonstrate electromagnetic waves we find that it is waves. It is a "both–and", it is both particles and waves, in spite of the apparent contradistinction. Two complementary properties of light have been demonstrated. In reality there is no dualism and no contradiction in the problem. We must remember that the type of the answer is dependent upon the method of investigation. "Som man råber i skoven, får man svar"—"As the cry in the wood, so the same is the answer in the echo".

A phenomenon may have, and often has, more than two complementary aspects. Our dilemmas with their apparent contradistinctions may be artificial and due to incomplete definitions of the concepts. It is only with all the various complementary descriptions, when considered together, that we can say that we have exhausted the knowledge obtainable concerning any subject.

Bohr has emphasized that very often our different dilemmas are due to wrong analogies from the macroscopic world, and that it would often be much more correct in the microscopical world to seek our analogies in the quanta world. One cell of the retina will almost be able to respond

to one light "quantum-of-action". Still, we must remember that we often interact with the object examined when we are dealing with microscopic subjects.

Hegel has pointed out how our thinking takes place as a result of interaction between logical contrasts. Our brain has difficulties in accepting dualisms. We cannot imagine a concept without looking for a certain contradistinction to it in logical contrary terms. No wonder that we will often blunder in this daily "either–or" world of ours.

THE CONCEPT OF COMPLEMENTARITY

Now, Niels Bohr has again unbound our horizons through his concept of complementarity. We are learning how to avoid the pitfalls into which the usual track will lead our thoughts. He has shown us how these difficulties in our capacity for thought may be overcome. The dilemmas we meet with should be analysed for complementarity. The most careful definitions should be elaborated before dualisms are accepted or discarded as such. "Logical contradictions" and "symmetrical reciprocals" should be treated in the same way, and the problem will often be solved by this procedure and new knowledge won. However, even when we use the concept of complementarity we are wrongly apt to think as if only couples of complementary concepts exist. Nevertheless, the use of the concept of complementarity has enabled us to overcome the difficulty of our habit in thinking in logical contrasts. The concept of dialecticism has thus been widened.

I feel that in the future these thoughts will influence our mode of thinking more and more, and I will just mention a few examples where the effects on our problems in physical medicine are obvious: the classical problems—if energy or matter is the infinitesimal unit, if free-will exists, if time and space are existing in us or if we are existing in time and space—have all been elucidated in a new way and seem less contradictory to our intellect than before. The laws of the conservation of energy and matter have been widened through the evolution of these ideas. Our free-will is conditioned already, to some extent at least, by the interaction with the problem in hand, by the surrounding circumstances, by the moment in time and by the experience of the past. An instructor of remedial exercises is, for instance, speaking of relaxation during work when all superfluous work should be avoided. The complementary concept is concentration, and so consequently "You should concentrate to relax and relax to concentrate". This is more correct than to speak of the concept of relaxation alone. You might ask, "Relaxation for what—for mental stress?" One should prefer the term "Co-ordination of relaxation and concentration".

THE NEED FOR CLEAR DEFINITIONS

At this point I would like to quote Dr. Macdonald Critchley: "Our knowledge of volitional movement has been erected upon a tripod of clinical observation, experimental physiology and psychology. Our present-day nomenclature needs revision: 'voluntary', 'volitional', 'willed', 'purposive', 'purposeful', 'deliberate', have been inappropriately used as if synonymous, and they have been contrasted with 'involuntary', 'unwilled', 'spontaneous' or 'pseudo-spontaneous' activities." Still more unjustified is a careless reference to volitional movements as though they were mediated specially along pyramidal pathways, initiated by the cells of the motor cortex and comparable with the effects of electrical stimulation. There are degrees of volition, and most of the initiation of the cross-striated muscles is released from the periphery and from the proprio-receptors as skilled or reflexly released contractions which are only under a certain degree of supervision from the higher centres.

We speak of posture only, but we should distinguish between carriage, stance, deportment, poise, etc., and make our clear definitions before we take up theoretical discussion. Posture is a complex variable subject and should be handled as such.

We speak of muscle contraction, although we know that during relaxation of the muscle the more active work is done, the molecular chains are expanded, and energy is used. The molecular chains are made ready for use by active chemical reactions during the process of relaxation. During a muscle contraction the chains merely collapse in the same way as will an expanded spring when suddenly released.

We speak of static and dynamic muscle work, well knowing that very often the single fibre will alternate or work rhythmically, and parts of one muscle will relax while others contract.

We may discuss whether a nerve stimulus is chemical or electrical. If we measure chemical alterations in potassium we find chemical alterations, but if we measure electrical potentials we find electrical variations. Again "both–and". If we measure with thermocouples we take away heat, prevent radiation and convection, and influence evaporation. We disturb the processes we are trying to study, a fact which becomes of growing importance as our methods of measurement improve. In the microscopy of the capillaries we heat the vessels by the light we are using to observe them.

Muscle tone is a variable and very complex subject. It is an integrated product of interacting reflex tonus, consistency, degree of extension or contraction, passive elastic tensions again influenced by temperatures, mechanical deforming forces, hydrostatic pressure, blood circulation, oxidation, osmotic

forces, etc. No wonder discussions arise concerning this subject. We are no longer allowed to speak of "muscle tone" as a whole, as so many do.

It is our duty to study the quanta of action of the muscles and nerves. We are no longer allowed to adhere to the concepts from the macroscopical world and the macroscopical anatomy in our reasoning.

Most of our tissues are innervated from at least two systems. This is the case with glands, muscles, and vessels. The humoral chemical regulation is often doubled and interacts with the nervous regulations. No wonder our results are often only relative and the product of interacting forces. It is essential that we should employ complementarity in our descriptions.

Is rheumatoid arthritis an infection or not? The answer may be, and is, dependent upon our methods of investigation. Are rheumatoid arthritis and ankylosing spondylitis the same disease or not? The answer is, "You may discuss if two diseases have the same aetiology or not, but so long as the aetiology is unknown you cannot give a dogmatic answer." Diseases should be looked upon as reactions or interactions between the individual and agents, surroundings, circumstances, etc.

Is virus living or not? It can only multiply in interaction with living cells. The answer is again, not "either–or", but the complementary concept of "both–and". The cells are influenced by the virus, and the virus by the host cells.

PATTERNS LARGE AND SMALL

Let it be admitted that my examples are poor and incomplete and my approach to these subjects dilettantish only. I know it. However, it has been my endeavour to point to the direction in which we should strive to know how to handle these problems, so that we weave the filling between the given warp threads.

In the kaleidoscope, my dearest plaything as a child, the same pieces of glass make so many different patterns. Children seek coloured stones along the sea-shore and make them into patterns. The patterns unfold and alter as they expand. The same stone may be placed in various different patterns. New stones make new designs. The pattern may be built of small or greater stones. It may be made of grains of sand, and is then easily disturbed, if we measure the distances between the grains. In the same way we interfere with the processes we are studying. The pattern may be huge and built of boulders. It may be so huge that we are unable to see it even if we are placed near it or within it; only from the air will we be able to see it. Without an aeroplane and without a magnifying glass the patterns may remain obscure. The aeroplane will be useless for grains of sand, the magnifying glass for granite boulders. We do not see the

pattern. Often we may not know how to see it. Still it exists, even at night, when children have left their play, and nobody looks, and darkness covers the seashore.

"Our brief", as Lord Horder said, "is a wide one . . . a very wide one."

References

BJERGE, T. (1954) *Elektron- og Atomfysik*. Copenhagen.

BOHR, N. (1929) *Atomteori og Naturbeskrivelse*. Københavns Universitets Festskrift.

——— (1949) Discussion with Einstein on Epistemological Problems in Atomic Physics. *Library of Living Philosophers*, **7**, 201.

——— (1951) "Medical Research and Natural Philosophy." Second International Poliomyelitis Conference, Copenhagen.

HEISENBERG, W. (1930) *Die physikalischen Prinzipen der Quantentheorie*. Leipzig.

AN APPARATUS FOR BUERGER'S EXERCISES IN THE HOME

IN cases of peripheral arterial disease even the threat of gangrene often fails to impress the patient with the imperative need for him to carry out Buerger's exercises. This applies with even greater force to the aged patient with arteriosclerosis, especially when there is associated cerebral sclerosis, which tends further to lower the threshold to cerebration and to fatigue. Because of the exhausting and boring nature of these exercises, and especially their long duration—namely, three positions in each cycle, from three to six cycles in each session and two to four sessions a day, a total of from three to six hours—a patient will need a lot of encouragement before he is likely to persevere with them.

Buerger originally suggested that the elevated limb be held by a "suitable support", but to arrange this in the home has always presented a problem. In the domiciliary treatment of the younger and the less debilitated patient, the back of an upturned, tilted chair placed at the foot of the bed is useful. But this regimen, as well as that practised in hospital with its more elaborate equipment, demands a great deal of energy on the part of the patient in having to sit up repeatedly to hang the legs over the side of the bed. This makes these methods impracticable for the older and feebler patient, especially when there is associated cardiac decompensation. Therefore some device had to be evolved permitting the patient, still in the supine position, to raise the leg and lower it over the side of the bed without effort, and this has been achieved in the simple apparatus here described and illustrated.

DESCRIPTION OF APPLIANCE

The principle is that of the "pulley and cord". The bare essentials are a stable, inexpensive stand, made of wood or metal, for the attachment of the pulley, 15 feet of sash cord, and a slipper of felt, one of this material being adaptable to either foot. The stand consists of an upright post, 5 feet 6 inches in height, firmly fixed at its lower end to a transverse bar which projects on either side to form two of the legs. Projecting forwards from the junction of the bar and post on the weight-bearing side are two more legs set at 60 degrees from one another and at 60 degrees from the two lateral legs. These forward-projecting legs should be 2 feet long to prevent the apparatus toppling over. At the top of the post is a projecting arm, 12 inches long, to the end of which the

pulley is attached. The cord should be sewn to the slipper in such a position that the weight of the limb is carried at a level immediately above the tuberosity of the os calcis. If the cord is attached at a lower level the slipper tends to be pulled off when the leg is raised. The pulley may be of the fixed type or have a swivel attachment. The advantage of the fixed pulley is that the patient can, with a sideways flick, lock the cord between the wheel and the pulley casing, and so relieve the strain on the arms involved in keeping the leg elevated; that of the swivel pulley, that it angles itself at all stages to any change of position of the limb. Knots may be tied in the cord to record the number of cycles.

THE APPLIANCE IN USE

With this appliance even the feeble patient can carry out in the supine position, and with little effort, active ankle and foot exercises which are normally performed with the legs hanging down; at the same time its use promotes easy and all-unconscious exercise beneficial to the upper limbs. It is true that with the pulley system limbs must be treated separately, which takes longer, but this is no disadvantage, as the operation of the simple mechanism, together with the need to keep his attention continually keyed up to control

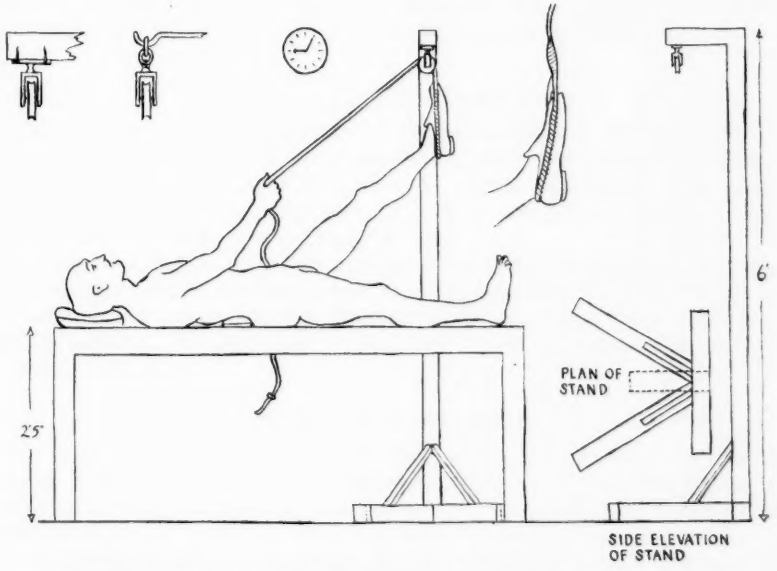

Diagram showing the use of the apparatus and details of its construction.

the exercises by the use of a near-by clock, help to encourage, even amuse, the patient, thus relieving the tedium of what must seem to him a very long day. The leg and foot can be kept warm with some suitable wrapping throughout the actual performance of the exercises. Only infrequent tests of the blanching and erythrocyanosing times are needed, as the time factor is fairly constant for all patients.

This device owes its inspiration to my seeing, and making use of, a hook in an oak beam over the bed of a patient with arterial disease, who was threatened with amputation of both legs a year ago. This patient has persisted conscientiously in doing these exercises with the aid of a pulley and cord, and so successfully that he is now able to walk half a mile without discomfort.

ACKNOWLEDGMENT

I am indebted to Miss C. Moody for the drawing.

J. B. JESSIMAN

Department of Physical Medicine.
Malvern General Hospital.

THE INTERNATIONAL CONGRESS OF PHYSICAL MEDICINE, COPENHAGEN, 1956

REPRESENTATIVES from 28 countries attended the International Congress of Physical Medicine at Copenhagen from August 20 to 24, 1956. It was the second congress to be held under the auspices of the International Federation of Physical Medicine, the London Congress of 1952 being the first. Two hundred and eighty-two full and 148 associate members were present; the British contingent totalled 81.

OPENING SESSION

The opening ceremony took place in the Festival Hall of the University of Copenhagen in the presence of Her Majesty Queen Ingrid of Denmark. After the company had stood in memory of the late Lord Horder, Dr. Frank Krusen, President of the International Federation, lit the Ceremonial Lamp which Lord Horder had presented for the London Congress. He then introduced to the assembly the President of the Congress, Dr. Svend Clemmesen, giving an account of his career and professional achievements, and finally investing him with the Baruch Chain of Office. The Congress was officially declared open by the Minister of Education, Mr. J. Bomholt, who cordially welcomed members to Denmark. He was followed by Dr. Ole Sylvest, who gave a brief history of the Danish Society of Physical Medicine, of which he is President. Dr. Clemmesen then delivered the principal oration, entitled "Physical Medicine and Physics". (This is reproduced in full at page 3.) During the ceremony songs were sung by the Universitet Studenter-Sangforeningen.

SCIENTIFIC PROGRAMME

The scientific sessions were held in the Christiansborg Castle. Two halls were used for the lectures. In the larger hall, previously the equivalent of our House of Commons, there were simultaneous translations into English, French, and Spanish. In the smaller hall, a fine room previously the meeting place of the Danish House of Lords, these translation facilities were not available.

During the Congress 78 papers were presented and 21 films shown. Summaries of the papers appear in the Supplement to the August issue of "Orthopaedics and Traumatology" in *Excerpta Medica*. The titles of the main subjects and the principal speakers, together with the names of the other British speakers, are listed in the Appendix to this report.

SOCIAL PROGRAMME

On the first night of the Congress the Municipality of Copenhagen was host at a reception at the Town Hall. The members were addressed in the Great Hall by the Chief Mayor, Mr. Julius Hansen, and Dr. Krusen responded. After a lavish buffet supper the delegates visited the many fine rooms of the building. On the following night an official reception was held at the Christiansborg Castle. Once again the Congress was honoured by the presence of Her Majesty the Queen, who stayed for

over two hours and spoke to many of the delegates. This was a colourful and memorable evening. On the third night there was a special concert in the Radio House of Copenhagen, where a programme of music by Danish composers was played by the Symphony Orchestra of the Danish Broadcasting Corporation. Finally, on the last night of the Congress the Congress Committee gave a splendid banquet at the Restaurant Wivex.

In addition to these receptions the official representatives were entertained on August 19 by the Danish Medical Association at the Domus Medica. On August 21 the official representatives and the principal speakers attended an afternoon reception at Kommunehospitalet, where the guests were able to inspect the new Department of Physical Medicine. This fine department, which is under the direction of Dr. Clemmesen, occupies five floors and contains ample laboratory accommodation for research.

Finally mention must be made of one function not on the official programme—namely, the American "Treat Breakfast" organized by Dr. Sidney Licht. This was given at the Hôtel d'Angleterre on the morning of August 21, and was attended by 25 American physicians and 60 physicians from 15 other countries.

GENERAL MEETING

The General Meeting of the International Federation of Physical Medicine was held on Friday, August 24, immediately before the Closing Ceremony. The officers for the next four years were appointed: President, Dr. Svend Clemmesen; Secretary, Dr. Philippe Bauwens; Treasurer, Dr. Hugh Burt; Deputy Medical Secretary, Dr. A. C. Boyle. It was decided that the permanent office should remain in London. It was also agreed that the next International Congress should take place in the U.S.A. in 1960.

COMMENTS ON THE CONGRESS

An international congress may be regarded from two points of view, the scientific and the social. The scientific point of view can also be divided into two: first, what may be called the formal side—that is to say, the reading of scientific papers and the discussion which follows them; and, second, the informal side—the opportunity given to members to make or renew acquaintance of their colleagues from other countries and discuss with them matters of mutual interest.

For those attending an international congress the informal scientific side is much the more important. At Copenhagen this was most satisfactory, for the number of delegates was not too large and there was ample opportunity for meeting and discussion.

On the formal scientific side there was some criticism on the grounds that little new work was reported, that some of the papers were not of the standard hoped for, and that discussion was limited. Such criticism is heard time and again at all international congresses, and there are many explanations for it. In the first place, a twenty-minute paper, of which a summary must be given some months before, is not a good medium for the reporting of new scientific work. Secondly, free discussion is likely to be limited because of language difficulties. Thirdly, some papers will inevitably be sub-standard unless rigid selection is insisted on. Desirable, however, though this selection is, it has the practical difficulty that in these days the reading of a paper is

often a necessary prerequisite for delegates to be granted expenses or even to be allowed to go to a conference at all. To enable or to encourage numbers of delegates to attend, therefore, some licence in the acceptance of papers is necessary. It would, however, be of benefit for future congresses if certain sessions were reserved for selected topics in which only invited speakers were asked to contribute.

Nothing could have been better than the social side of the Congress. Copenhagen is an ideal place for such a meeting, and the Danish people are by nature extremely hospitable. The Organizing Committee are indeed to be congratulated on their arrangements. To them also belongs much of the credit for the excellent and harmonious atmosphere of the whole Congress.

H. A. B.

APPENDIX

The three main subjects discussed at the Congress, together with the principal speakers, are listed below:

1. The heat regulation and peripheral and central circulation as basic problems within physical medicine. *Principal speaker:* Dr. P. Bauwens (Great Britain).
2. The striated muscle. Clinical and physiological problems in relation to physical medicine. *Principal speakers:* Dr. F. Krusen (U.S.A.), Dr. B. R. Kaada (Norway), Dr. S. Clemmesen (Denmark), Dr. K. M. Walthard (Switzerland), Dr. W. D. Paul (U.S.A.), and Dr. J. I. Routh (U.S.A.).
3. Rehabilitation. *Principal speakers:* Dr. G. Gingras (Canada), Dr. K. H. Backer (Denmark), Dr. A. B. C. Knudson (U.S.A.), Dr. C. B. Wynn Parry (Great Britain), and Dr. Howard A. Rusk (U.S.A.).

In addition, one day was devoted to clinical communications.

British speakers other than those listed above were: Dr. F. Bach (Film: its use in physical medicine and rehabilitation), Dr. P. J. R. Nichols (The early mobilization of the ankle-joint), Dr. W. S. Tegner (The diagnosis and treatment of chronic rheumatic conditions), Dr. W. F. Dunham (Classification of the infantile cerebral palsies), Dr. J. H. Cyriax (Hydrocortisone, clinical examination), Dr. B. O. Scott (Traction in the treatment of spinal derangement), Dr. J. H. Crosland (An analysis of possible aetiological factors in cerebral palsy), Dr. N. R. W. Simpson (Critical assessment of treatment of degenerative arthritis of the knee), and Dr. M. Q. Birkbeck (Panniculitis—or the tender flesh syndrome).

BRITISH ASSOCIATION OF PHYSICAL MEDICINE

ANNUAL MEETING, 1957

Preliminary Announcement

THE Annual Meeting will be held at the Middlesex Hospital, London, W.1, on Friday and Saturday, April 5 and 6, 1957. A full programme will be circulated in March, but the provisional arrangements are as follows:

Friday, April 5

Morning	Short papers.
Afternoon	Discussion on "Poliomyelitis".
Evening	Annual Dinner at the Royal College of Surgeons.

Saturday, April 6

Morning	Annual General Meeting.
	X-ray Competition.
Afternoon	Clinical Meeting.

COURSES IN THE PROBLEMS OF PROSTHESES AND RE-EDUCATION IN WALKING

COURSES in the problems of prostheses and re-education in walking are being arranged about every three months for physical medicine specialists at the Limb Fitting Centre, Queen Mary's Hospital, Roehampton, London, S.W.15. Details of these courses can be obtained from the Regional Hospital Boards or direct from Queen Mary's Hospital.

NORTH AND MIDLANDS PHYSICAL MEDICINE CLUB

THE Club held its third meeting at the Edgar Allen Physical Treatment Centre, Sheffield, on October 6, 1956, at the invitation of the House Committee.

Dr. J. W. T. Patterson was elected Chairman, and Dr. J. Euan Dawson Honorary Secretary, for the year 1957.

After inspecting the Edgar Allen Physical Treatment Centre, members went to Lodge Moor Hospital for sherry and lunch. In the afternoon Dr. A. G. Hardy, M.B.E., consultant in charge of the Spinal Injuries Unit at Lodge Moor Hospital, with the aid of patients, slides, and a film, discussed the complications and management of traumatic paraplegia.

Following this Dr. E. G. Herzog, Surgeon-Superintendent of King Edward VII Hospital, gave a demonstration of the treatment of poliomyelitis in the new physiotherapy and hydrotherapy department.

Lunch and tea were generously provided by Sheffield No. 3 Hospital Management Committee.

Members and their wives later attended a Dinner Dance at the Rising Sun Hotel, Bamford, Derbyshire.

The next meeting is to be held in Droitwich.

HARVEIAN TERCENTENARY CONGRESS, 1957

JUNE, 1957, marks the tercentenary of the death of William Harvey. To commemorate the occasion it is proposed to hold an International Scientific Congress on the Circulation at the Royal College of Surgeons, London, from June 3 to 7, 1957. The proposed programme is as follows:

"*A Review of the Present Knowledge of the Circulation*"

MONDAY, JUNE 3

10 a.m. Introduction by the President.

10.15 a.m. "The Circulation from the 17th to the 20th Century."
Professor K. J. Franklin; Dr. F. A. Willius, Mayo Clinic; Professor John Fulton, Yale University; Sir Charles Dodds.

2.15 p.m. "The Regulation of the Circulation." Chairman: Professor G. W. Pickering.
Dr. Louis Katz, Chicago; Dr. Paul Wood; Dr. —. Matthes, Heidelberg.

TUESDAY, JUNE 4

10 a.m. "The Results of Cardiac Surgery." Chairman: Sir Clement Price-Thomas.
Sir Russell Brock; Professor de G. d'Allaines, Paris; Professor C. Crafoord, Sweden; Dr. M. Campbell.

2 p.m. "The Coronary Circulation." Chairman: Dr. C. S. Beck, Cleveland.
Dr. D. E. Gregg, Washington; Dr. Geoffrey Dawes.

4 p.m. Round-table discussion with questions.

WEDNESDAY, JUNE 5

10 a.m. "The Pulmonary Circulation." Chairman: Professor J. McMichael.
Dr. Andre Cournand, New York; Professor C. V. Harrison (Pathology); Dr. Stig Radner, Sweden (Radiology).

2 p.m. Occasional papers.

THURSDAY, JUNE 6

10 a.m. "Cerebral Circulation." Chairman: Dr. MacDonald Critchley.
Professor S. Kety, Philadelphia; Professor T. Alajouanine, Paris; Dr. E. H. Botterell, Toronto.

2 p.m. "Splanchnic Circulation." Chairman: Professor Sir James Learmonth.
Dr. Stanley Bradley, New York; Dr. S. Sherlock; Professor R. Milnes Walker.

FRIDAY, JUNE 7

10 a.m. "The Peripheral Circulation."
"Circulation through the Limbs"—Professor H. Barcroft.
"Vascular Innervation"—Professor W. D. M. Paton.
" Pathology of Vessels"—Professor J. H. Dible; Professor C. G. Rob.

2 p.m. Participants may visit various hospitals or travel to Folkestone.

SATURDAY, JUNE 8, at FOLKESTONE. Chairman: Sir Geoffrey Keynes.

10.30 a.m. "Harvey's Birthplace"—Professor T. Hare.
"Harvey at Cambridge"—
"Harvey at Padua"—Professor A. Cawadias.
"Harvey the Scientist"—Dr. W. R. Bett.

REVIEWS OF BOOKS

ELECTRODIAGNOSIS AND ELECTROMYOGRAPHY. Edited by Sidney Licht. *Pp. 255. $10.00. Published by Elizabeth Licht, 360 Fountain Street, Newhaven, Connecticut. 1956.*

This book is written "by physicians for physicians", and in particular for the specialist in physical medicine. Dr. Licht, in an interesting historical survey, traces the development of electrodiagnosis from the discovery of electricity by William Gilbert in 1600. Squadron-Leader Wynn Parry has contributed an excellent chapter on strength duration curves. The chapter on electromyography is disappointing, and the authors fail to distinguish clearly between those electrical potentials which are obtained in the absence of muscular activity and those found on voluntary contraction. Some of the chapters, including one by Dr. Ronald Harris on chronaxie, discuss certain methods of electrodiagnosis which are now obsolete; some chapters are too technical for the average physician; and the two appendices on electroencephalography and electroretinography are largely irrelevant.

As this book is a comprehensive study of the subject and has a large bibliography, it will be of value as a reference book to the practising specialist in physical medicine. Although it may be useful to candidates for the Diploma in Physical Medicine, it is not easily readable, and I do not recommend it as a book to be taken on a train journey.

S. MATTINGLY

PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON THE PEACEFUL USES OF ATOMIC ENERGY. Volume 10. RADIOACTIVE ISOTOPES AND NUCLEAR RADIATIONS IN MEDICINE. *Pp. 544. 57s. New York: United Nations. 1956.*

The International Conference on the Peaceful Uses of Atomic Energy was held at Geneva in August, 1955. The papers submitted have been published in sixteen volumes, Volume 10 of which is devoted to the applications of radioisotopes and radiation to medicine. It contains 85 papers divided into four sessions.

The first session is, unfortunately, misleadingly headed "Isotopes in Technology and Industry". It consists entirely of four short general papers, one each from the U.S.A., the United Kingdom, Japan, and France; these are simple reviews in non-technical language of the uses to which radioisotopes have been applied in medicine and biology in these countries. This session was followed (as were all the sessions) by a detailed record of the discussions arising from the papers.

The second session contains 27 articles on "Therapy", eight of which were presented and discussed. The session opens with generalized papers on "Medical Applications of Some Radioactive Isotopes", by Kozlova (U.S.S.R.), and "Some Problems of Radiotherapeutics", by Mitchell (United Kingdom)—the latter an excellent review of the therapeutic practice and problems of the Cambridge Radiotherapeutic Department. Papers follow on the treatment of neoplastic disease, and of hyperthyroidism in the U.S.A., France, Switzerland, and Portugal. The contribution from the U.S.A. (19 out of 27 papers) demonstrates the widespread use of radioisotopes developed there. Other contributory countries are the United Kingdom, Brazil, Portugal, France, Switzerland, and Belgium. Many papers are generalized,

but several are detailed studies of hyperthyroidism, irradiation hypophysectomy, and the use of radioactive cobalt. Most papers are well documented and have excellent reference lists.

The third and fourth sessions, containing 34 and 20 submitted papers, respectively, are on "Diagnosis and Studies of Disease" and are concerned with fundamental research and diagnosis.

In session three, the bulk of the papers again are from the U.S.A. (14 out of 34), but there are also four from Roumania (all on the thyroid). The papers are particularly varied; some reviewing the use of radioactive isotopes in diagnosis in the United Kingdom, U.S.S.R., and the Argentine are suitable for the non-specialized reader. Fourteen papers are concerned with the thyroid gland, many covering the same ground in their review of current routine practices, and the amount of detail given varies widely. Papers of particular interest are "Possibilities and Limitations of *in vivo* External Counting Techniques in Biology and Medicine" and "Positron-emitting Isotopes in Diagnosis", both from the U.S.A.

Session four continues diagnosis and studies of disease and has 20 articles, mainly on research. This section contains the most interesting papers, notably "The Use of Isotopes in Biochemical and Medical Research", by Hastings—an excellent review of the present position in the U.S.A., with a most comprehensive bibliography; "The Use of Isotopes in Analysis of Metabolic Disorders"—also from the U.S.A., and remarkably concise and informative; and "The Application of Radioactive Isotopes to the Study of the Biochemistry of Muscles", by Ferdman of the U.S.S.R., which should be read by all interested in muscular disorders.

It is impossible adequately to review a publication of this type, as the papers differ so greatly, ranging from broad, relatively non-technical reviews to highly detailed papers on specialized subjects. The proceedings of the conference indicate the worldwide use of radioisotopes and the similarity of experience in the main centres, and emphasize the enormous contribution made in this field by the U.S.A. The detailed discussions reported after each series of papers, the excellence of the production, and the rapidity with which the volume was brought out are all noteworthy features. However, the absence of an index is a disadvantage. It is refreshing in these days to find so well produced and illustrated a book at under £3.

R. HARRIS

ABSTRACTS OF THE LITERATURE

The Aged Shoulder. S. M. ALBERT and A. M. RECHTMAN. *Geriatrics*, 1956, **2**, 342.

In a review of 250 aged shoulders, 55 were found to show varying amounts of calcification in the rotator cuff. This was commoner in women, and only 9 patients had pain. There was no evidence that the deposits resulted from the wear and tear of repeated trauma. They had no effect on joint movement.

The authors conclude that calcification of the hard, dense type in the rotator cuff is without clinical significance, although when it invades the subacromial bursa it may act as an irritant.

G. O. STOREY

Relation of Dietary Intake to Bone Fragility in the Aged. O. B. HAYES, L. J. BOWSER, and M. F. TRULSON. *J. Geront.*, 1956, **2**, 154.

Dietary histories of 47 subjects (16 males, 31 females) who were hospitalized with fractured femurs were compared with the dietary histories of 47 control subjects (16 males, 31 females) in an attempt to determine the extent of the influence of dietary intake on development of bone fragility in the aged. All subjects were over 65 years of age. Data were separated according to sex. No significant differences between adult eating habits of fracture and non-fracture subjects were demonstrated. Some indication was apparent that older people who had suffered a fracture of the femur tended to be somewhat underweight as compared with older people who had no history of broken bones. Results of the study appear to support the concept that the onset of bone fragility in the aged is a composite effect of many factors and is probably more intimately related to endocrine changes, decreased activity and loss of muscle tone than to level of nutrition.

Authors' summary

Some Aspects of Cerebral Palsy and its Management. G. A. LENNANE. *N.Z. med. J.*, 1956, **55**, 18.

This is an up-to-date review of the aetiology, morbid anatomy, modern classification, management, and treatment of cerebral palsy, based on the author's experience at the Queen Elizabeth Hospital, Rotorua, where he was responsible for the initiation of a residential unit. He stresses (1) the importance of treatment being started at the earliest possible moment, and (2) the value of relaxation. Training the child to do the things he would normally learn by instinct is the basic essential. It is pointed out that the co-ordinated efforts of a team of specially trained workers are required over a long period. Facilities available in New Zealand for the treatment of cerebral palsy are described.

[This is a valuable addition to the rather meagre literature on the subject of cerebral palsy, and is well worth perusal.]

A. ROWATT BROWN

The Relative Susceptibility to Injury of the Medial and Lateral Popliteal Divisions of the Sciatic Nerve. S. SUNDERLAND. *Brit. J. Surg.*, 1953, **12**, 300.

The author's studies lead him to confirm the view that in injuries of the sciatic nerve the lateral popliteal division is more frequently and more

severely involved than the medial division. He puts forward arguments in support of a theory that the large size of the funiculi and their smaller number, together with the smaller amount of supporting connective tissue in the lateral popliteal division, as opposed to the reverse arrangement in the medial division, is the chief contributory factor in its greater susceptibility to injury. In a study of the anatomical course taken by the two divisions in the thigh the lateral division was found to be fixed and angulated at the sciatic notch and neck of the fibula, resulting in great stretching between these two unyielding points, and consequent damage, when the sciatic nerve is subjected to violent lateral displacement. As the nerve is less securely fixed inferiorly, stretch of the medial division can be dissipated over a greater length of the nerve.

R. J. TALBOT

Die sogennante "Arachnitis Spinalis" und ihre Abhängigkeit von Wirbelsäulenaffectionen. H. FELTEN. *Nervenarzt*, 1954, **25**, 364.

The term "arachnitis" was first introduced into clinical neurology by Oppenheim and Krause (1906), who three years later described the first operation on a prolapsed lumbar disk, without realizing the significance that would be attached to disks 30 years later. Terms such as "meningitis serofibrinosa circumscripta spinalis" gained considerable currency and gave the impression that an inflammatory lesion was at work, and Barré (1933), although he still supported the thesis of a primary inflammation, nevertheless noted a tendency to spontaneous remission and advised root resection for intractable pain. Veraguth (1944) felt certain that a mechanical component was present, and French (1946) found a "local arachnoiditis" in 13 cases out of 200 which had been operated on for prolapsed intervertebral disk. This secondary manifestation, which follows compression (usually prolapsed intervertebral disk), should be designated by such terms as "secondary localized meningiopathy" or "(reactive) meningiosis".

DAVID PREISKEL

Thrombosis of the Basilar Artery with Softenings in the Cerebellum and Brain Stem due to Manipulation of the Neck. F. R. FORD and D. CLARK. *Johns Hopk. Hosp. Bull.*, 1956, **98**, 37.

The authors describe what appears to be a well-defined syndrome resulting from thrombosis of the basilar artery as a consequence of manipulation of the neck. No dislocation or fracture of the cervical spine was found radiologically or at post-mortem. Symptoms developed immediately after manipulation, which in the authors' two cases consisted of rotation in a vertical axis. Insufficient data are available as to the nature of the manipulation in three other cases. It is suggested that excessive rotation of the neck as distinct from hyperextension, which is recognized to result occasionally in damage to odontoid ligaments and the spinal cord, results in damage to vertebral arteries with interruption of blood flow into the basilar system and thrombosis due to stasis.

R. I. MEANOCK

Arterial Disease as a Cause of Pain in the Buttock and Thigh. G. BONNEY. *J. Bone Jt Surg.*, 1956, **38B**, 686.

This paper from Oswestry describes ten cases of arterial disease which

presented with pain in the buttock and hip. All the patients were originally diagnosed as suffering from either osteoarthritis of the hip or degeneration of the lumbosacral disk. The pain was later found to be due to obstruction at the aortic bifurcation or in the iliac vessels, although only one patient had marked peripheral ischaemic changes.

[This paper is a salutary reminder of a possible diagnosis when dealing with pain in the buttock.]

P. J. R. NICHOLS

Disc Degeneration and Lumbago. L. SÖDERBERG and L. ANDRÉN. *Acta orthop. scand.*, 1956, **25**, 137.

Difficulty is experienced in assessing the height of a normal disk, and particularly the lumbosacral disk. Radiological proof of disk degeneration requires evidence not only of decrease in height, but also of sclerosis of the vertebral margins and/or osteophytes.

In this article are described investigations aimed at proving that protrusion can occur to a radiologically normal disk more readily than to one showing degeneration, since with increasing age the disk undergoes dehydration with consequent reduced risk of protrusion. The study covered 310 patients with neurological signs and sciatica from disk protrusion who were treated conservatively in hospital. The radiological findings and the incidence of disk degeneration in different categories of patients presenting with sciatica, also the incidence of disk degeneration in patients with and without back symptoms, are analysed graphically. X-ray changes were found in many of those without symptoms, and equally no radiological changes were found in cases of acute sciatica. There was some evidence that disk changes were more marked in cases where prominent spinal changes were present, especially in Scheuermann's disease. The investigation did not, however, reveal any correlation between X-ray and clinical findings.

V. CYRIAX

Statistical Experimentation in Therapeutics. R. WRIGHTON. *Brit. J. prev. soc. Med.*, 1955, **9**, 135.

As exponents of physical medicine are at present being rightly urged to be more scientific and statistical in their approach, this short paper will be of interest as giving another side to the picture. The author seriously doubts whether the statistical approach to assessment of curative measures is legitimate. He suggests that the statistical method is not in accord with ordinarily accepted scientific canons and that the consistent use of the method is not in accord with the aims of medical practice as commonly conceived. Furthermore the vocabulary of the method is disputed—no clearer definitions of such terms as "random", "probable", and "significant" than are implicit in Venn's logic of chance in 1866 have appeared since then. Progress has occurred in the mathematical but not in the logical structure of theoretical statistics.

The author's biggest and most alarming criticism is that the statistical method ignores the requirement that judgments formed from observational data should be made by contesseration with other information available in the field. The only conclusion to be drawn is that it is futile to attempt to develop a calculus of judgment or of decision.

[This is a stimulating paper which is well worth studying.]

C. B. WYNN PARRY

Physical Therapy in Thoracic Surgery. R. M. KROUT and E. M. SHIRES. *Amer. J. phys. Med.*, 1955, **34**, 342.

The results obtained in 240 Service patients who had undergone thoracic operations (165 thoracotomy and 75 thoracoplasty) are discussed in relation to posture and shoulder function. Active assisted exercises were started the day following operation; breathing and postural exercises were included, and "bed-posture" is emphasized. An average of four weeks' physical therapy was given after thoracotomy and ten weeks following thoracoplasty.

A C-shaped scoliosis was noted in 20% of patients after thoracotomy (half were correctable), and a primary thoracic scoliosis in 68% following thoracoplasty (one-third correctable). Shoulder movements and power were recorded in detail in 34 patients (10 post-thoracoplasty, 24 post-thoracotomy). Shoulder movements chiefly affected by thoracic surgery were abduction and forward flexion. Limitation was more severe and more general following thoracoplasty. Despite the operative trauma to the serratus anterior, 90% of patients regained full clinical power of shoulder movements. Only two cases of frozen shoulder occurred after thoracoplasty, and the authors conclude that this disability should not follow thoracic surgery except in the most unfortunate set of circumstances.

P. J. R. NICHOLS

Klinische Erfahrungen mit der gleitenden Saigmassage. W. BÖHMERT. *Med. Klin.*, 1954, **49**, 1887.

By means of an electrically driven vacuum pump dry-cupping can be carried out with a smooth and continuous motion (after lightly smearing the skin with liquid paraffin). The negative pressures and the size of the cups can be varied. The effect of the small cups is said to be similar to that of hand massage, but it is claimed that the large cups produce results which the masseuse cannot obtain. There is little, if any, skin hyperaemia, but a feeling of warmth deep in the tissues persists for one or two hours. It is stated that this type of treatment can be carried out without fatigue to the operator, but it is not claimed that hand massage can be completely superseded.

DAVID PREISKEL

Astragalectomy as a Means of Stabilization of the Foot after Poliomyelitis. H. C. VON HOLMBERG. *Acta orthop. scand.*, 1956, **25**, 207.

This is an interesting article on astragalectomy with reference to operative procedure, types of deformity, and degree of paralysis of the leg muscles. Slight additional shortening of the leg occurred in some cases; in others no shortening was seen, probably owing to improved function of the leg after the operation.

V. CYRIAX

The Use of Lively Splints in Upper Limb Paralysis. N. SMYTHE and C. B. WYNN PARRY. *J. Bone Jt Surg.*, 1955, **37B**, 591.

This paper from the Medical Rehabilitation Unit, Royal Air Force, Chessington, is an eloquent plea for the use of lively splints as a permanent or semi-permanent solution to upper limb paralysis, rather than reconstructive surgery. Lively splints are described, with illustrations, for: (1) disabilities of the elbow alone; (2) disabilities involving elbow, wrist, and hand; (3) disabilities involving wrist

and hand; and (4) disabilities involving the hand alone. Such splints can be made quickly, reducing the period of rehabilitation, and offer movement where surgery frequently can only provide stability.

[This collaboration between a physical medicine specialist and an occupational therapist in the design and manufacture of lively splints illustrates the modern concept of functional rehabilitation.]

P. J. R. NICHOLS

Oral Hydrocortisone Therapy in Rheumatoid Arthritis. E. W. BOLAND. *Ann. rheum. Dis.*, 1955, **14**, 232.

This is a summary of the results of treatment with oral hydrocortisone in 150 consecutive cases of rheumatoid arthritis over 9–36 months. In 24 patients treatment had to be discontinued for the following reasons: insufficient clinical response in 4; major complications in 2; complications unrelated to therapy in 1; death from other causes in 5; and remission in 12. Improvement was considered adequate in 50%. The results were much more variable when the arthritis was of relatively recent origin.

As time went on fewer patients showed adequate improvement. The disease was restrained in 72% at six months, but in only 59% at eighteen months.

G. D. KERSLEY

Spondylitis of Juvenile Rheumatoid Arthritis. R. E. BARKIN, J. S. STILLMAN, and T. A. POTTER. *New Engl. J. Med.*, 1955, **253**, 1107.

This is a survey of all cases of juvenile rheumatoid arthritis seen by the authors in four years at the Robert Breck Brigham Hospital, Boston. All cases showed spondylitis associated with peripheral joint disease, neither existing alone. Pain associated with stiffness and flexion deformity of the cervical spine was a common finding. One of the ultimate results was shortened stature due to interference with normal spinal growth. Out of a series of 71 children, 57 (80%) showed clinical or X-ray evidence of spinal involvement; the areas most commonly involved were the neck and lower back. Calcification of paravertebral ligaments was unusual, being seen in only two cases even with long-term follow-up. Females preponderated in the series in a ratio of about 2:1. Spondylitis was equally frequent in both sexes.

R. I. MEANOCK

Active Immobilization of Joints in Rheumatoid Arthritis. M. KELLY. *N.Z. med. J.*, 1956, **55**, 11.

A paper delivered at the annual meeting of the New Zealand Branch of the Empire Rheumatism Council.

Rheumatoid arthritis is a chronic disease which is characterized by critical attacks of acute arthritis in individual joints. If an acutely arthritic joint is immobilized the inflammation subsides forthwith. Afterwards a good range of movement usually returns.

Inability to use the hand is usually secondary to arthritis of the wrist. If the wrist is immobilized so that the fingers can be moved, the function of the hand will soon be restored. If the wrist has dropped, the deformity should be corrected under general anaesthesia. Immobilization does not cause ankylosis if there is cartilage in the joint. Rather it suppresses the pathological process which leads to ankylosis, and so prevents it.

Author's summary